

WHAT IS CLAIMED IS:

1. A probe for identifying a target point for a drill bushing comprising:
an elongated member; and
a first and a second drive coil mounted to the elongated member, the first and the second drive coils being proximate one another and being oriented so that a magnetic field generated by the first drive coil is orthogonal to a magnetic field generated by the second drive coil.
2. The probe of claim 1, wherein the first and the second drive coils are magnetic dipoles, the first magnetic dipole being mounted to the elongated member so that the dipole is horizontally transverse to the longitudinal axis of the elongated member and the second dipole being mounted to the probe so that the dipole is vertically transverse to the longitudinal axis.
3. The probe of claim 1 wherein the first and the second drive coils are mounted at the distal end of the elongated member.
4. The probe of claim 1 wherein the first and the second drive coils are separated by approximately 0.100 inches.
5. The probe of claim 1 wherein the first and the second drive coils are separated by no more than 0.100 inches.

6. A system for locating a target point for a drill bushing comprising:

a probe having two drive coils, the drive coils being mounted in the probe and being oriented so that a magnetic field produced by the first drive coil in response to an alternating current being coupled to the first drive coil is orthogonal to a magnetic field produced by the second drive coil in response to an alternating current being coupled to the second drive coil;

a guide having a pair of sensor planes mounted proximate a drill bushing, the sensor planes being orthogonal to one another, each sensor plane containing a pair of sensors, each sensor generating an electrical signal in response to magnetic fields produced by the first and the second drive coils; and

a computer coupled to the sensors in each sensor plane to receive signal readings from each sensor and to determine the target point of the drill bushing to which the pair of sensor planes is mounted.

7. The system of claim 6 wherein the first and second drive coils are driven by an alternating current of in the range of approximately 20 KHz to 30 KHz to generate magnetic fields.

8. The system of claim 6 wherein the first drive coil is driven by an alternating current of approximately 26.315 KHz to generate magnetic fields and

the second drive coil is driven by an alternating current of approximately 25 KHz to generate magnetic fields.

9. The system of claim 6 wherein the sensors in each sensor plane are inductive coil sensors.

10. The system of claim 6 wherein the sensors in each sensor plane are Hall effect sensors.

11. The system of claim 6 wherein the sensors in each sensor plane are magnetoresistive sensors.

12. The system of claim 6 wherein the computer determines alignment of the drill bushing with an axis of an intramedullary nail hole that is proximate one of the drive coils.

13. The system of claim 6 wherein the computer generates target indicia for identifying the target point of the drill bushing in the plane of one of the drive coils.

14. The system of claim 6 wherein the computer generates alignment indicia for identifying alignment of the drill bushing an axis for an intramedullary nail hole that is proximate one of the drive coils.

15. The system of claim 6 wherein the computer generates rotation indicia for identifying an angular orientation of the drill bushing to an intramedullary hole that is proximate one of the drive coils.

16. The system of claim 6 further comprising:

a display for presentation of indicia indicative of the drill bushing target point.

17. The system of claim 6, the probe further comprising:

an alternating current source for coupling to the first and the second drive coils; and

a switch for selectively coupling the alternating current to one or the other drive coil.

18. The system of claim 6 further comprising:

a first alternating current source for coupling to the first drive coil;

and

a second alternating current source for coupling to the second drive coil.

19. The system of claim 18, the probe further comprising:

a first switch for selectively coupling the first alternating current to the first drive coil; and

a second switch for selectively coupling the second alternating current to the second drive coil.

20. The system of claim 19 wherein the first and the second switches selectively couple the first and the second alternating currents to the first and the second drive coils for 760 μ seconds.
21. The system of claim 20 wherein the first and the second switches selectively decouple the first and the second alternating currents from the first and the second drive coils for 40 μ seconds.
22. The system of claim 18 wherein the first alternating current source is comprised of a clock signal generator and a first divider for generating the first alternating current from the clock signal generated by the clock signal generator; and
the second alternating current source includes a second divider for generating the second alternating current from the clock signal generated by the clock signal generator so that the relationship of the first and the second alternating currents are closely synchronized.

23. The system of claim 6, the guide further comprising:

a plurality of demodulation circuits for determining a reading for each sensor's response to a magnetic field generated by one of the drive coils.

24. The system of claim 23, the guide further comprising:

a phase locked loop for synchronizing a first reference signal to a signal from one of the sensors in a sensor plane.

25. The system of claim 24 wherein the phase locked loop synchronizes the first reference signal to a sensor signal by using the first reference signal shifted by 90°.

26. The system of claim 24 wherein a signal from the phase locked loop control generates first and second reference signals so that the first and second reference signals are substantially in phase with first and second alternating currents being applied to the first and second drive coils.

27. The system of claim 26 wherein the phase of the second reference signal is synchronized with the phase of the first reference signal at the beginning of a burst period.

28. The system of claim 26 wherein the demodulation circuits average the product of one of a first and a second reference signal with a signal from a sensor in a sensor plane to generate a sensor reading.

29. The system of claim 28 wherein the computer averages a plurality of sensor readings for each sensor before determining the target point.

30. The system of claim 29 wherein the computer averages a number of readings that corresponds to a sub-multiple of a power main frequency.

31. The system of claim 30 wherein the computer averages a number of readings that corresponds to a sub-multiple of a 50 Hz and a 60 Hz power main frequency.

32. The system of claim 6, the computer further comprising:
a transceiver; and
the guide further comprising a transceiver so that the computer may receive the sensor readings wirelessly from the guide.

33. The system of claim 6 wherein the computer generates active drive coil identification data for identifying one of the first and the second drive coils that is being coupled to the alternating current source.

34. The system of claim 33, the computer further comprising:
a transmitter for sending the generated active drive coil identification data to the probe; and
the probe further comprising a receiver for receiving the generated identification data from the computer.

35. The system of claim 6 wherein the probe generates active drive coil identification data for identifying one of the first and the second drive coils that is being coupled to the alternating current source.

36. The system of claim 33, the probe further comprising:
a transmitter for sending the generated active drive coil identification data to the computer; and
the computer further comprising a receiver for receiving the generated identification data from the probe.

37. A method for determining alignment with a hole in an intramedullary nail comprising:

generating first and second magnetic fields that are orthogonal to one another so that the origin of the fields is proximate a hole in an intramedullary nail;

determining sensor readings to the generated fields at sensors associated with a guide for a surgical tool;

computing a target location from the determined sensor readings.

38. The method of claim 37, the first and second magnetic field generation further comprising:

coupling an alternating current to first and second drive coils so that generation of the first and second magnetic fields do not overlap.

39. The method of claim 37, the first and second magnetic field generation further comprising:

generating a first alternating current and a second alternating current; and

applying the first alternating current to a first drive coil and the second alternating current to a second drive coil.

40. The method of claim 39, the first and second alternating current generation further comprising:
- generating a clock signal;
 - dividing the clock signal by a first integer to generate the first alternating current; and
 - dividing the clock signal by a second integer to generate the second alternating current.
41. The method of claim 37, the sensor reading determination further comprising:
- demodulating signals received from the sensors associated with a guide for a surgical tool.
42. The method of claim 41, the signal demodulation further comprising:
- generating a product of a first reference signal with a signal received from a sensor; and
 - averaging the product over a period of a burst used for first and second magnetic field generation to determine a sensor reading corresponding to the first magnetic field generation.
43. The method of claim 42 wherein the averaging is performed over a period of 760 μ seconds.

44. The method of claim 42, the signal demodulation further comprising:

generating a product of a second reference signal with the signal received from a sensor to determine a sensor reading; and averaging the product over the period of the burst to determine a sensor reading corresponding to the second magnetic field generation.

45. The method of claim 44, the demodulation further comprising:

synchronizing the first and the second reference signals with the signals received from the sensors.

46. The method of claim 45, the synchronization further comprising:

providing a quadrature of the first reference signal to a phase locked loop to adjust a generator for the first and the second reference signal.

47. The method of claim 46, the synchronization further comprising:

dividing a signal from the generator for the first and the second reference signal by a first integer to generate the first reference signal; and

dividing the signal from the generator for the first and the second reference signal by a second integer to generate the second reference signal.

48. The method of claim 37 further comprising:

wirelessly transmitting the determined sensor readings to a computer for the target position computation.

49. The method of claim 37 further comprising:

identifying one of the first and the second drive coils that is being coupled to the alternating current source.

50. The method of claim 49 further comprising:

sending the identification of the drive coil being coupled to the alternating current source; and

receiving the identification of the drive coil being coupled to the alternating current source.